STM POWER

The Future of Energy©

Game Changer

Stirling Engines at Landfills

Landfill Methane Outreach Program
6th Annual Conference and Project Expo
Renaissance Mayflower Hotel
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Energy Problems at Landfills

Emissions	**New NOx and PM regulations**
Methane Content	**Low grade 300 BTU methane**
Maintenance	**High maintenance costs $0.02/kWh**
Capacity	**Unused and stranded capacity**
Size	**Exploitation of smaller landfills**
Low Electric Rates	**Uneconomic buyback rates**

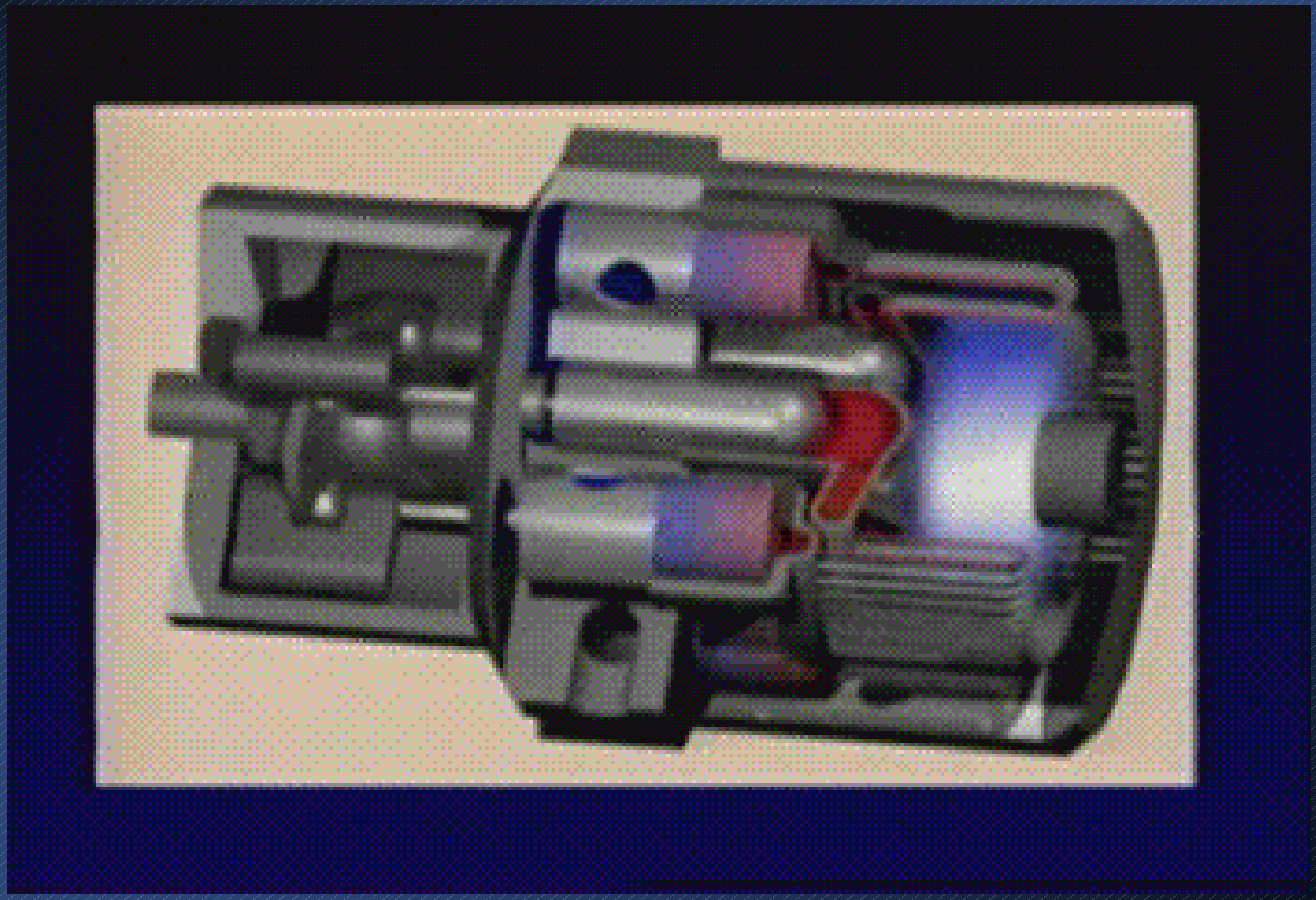
Solutions Offered by STM Stirling Engine

Problem	STM Solution
Emissions	CARB 2003 NOx compliant
Methane Content	Able to operate at 300 BTU
Maintenance	Estimated $0.008 per kWh
Capacity	Scalable from 52 kW (22 cfm)
Size	Plug and play for smaller landfills
Low Electric Rates	Other solutions

STM - Who We Are

- World leader in Stirling commercialization
- Prime mover engine assembly
- Renewable energy and distributed generation products
- 34 U.S. patents, 57 worldwide patents
- Senior management experience from Caterpillar, Deere, Cummins, Capstone, McDonnell Douglas, PricewaterhouseCoopers, Citibank and Daimler-Chrysler
- Backed by large energy technology venture capital
- $66 million invested to date
- Beta products shipped

STM Stirling Technology



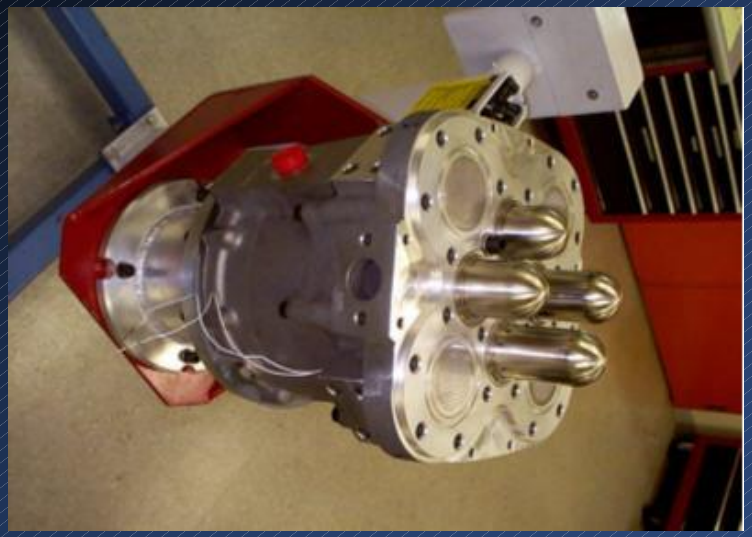
Simple Recip Engine Product

- 25 kW now
- 52 kW – July 2003 (1)
- 80 kW
- 160 kW
- 300 kW

4-120 engine is the prime mover for the 25 kW PowerUnit. 52 kW PowerUnit will use a 4-260 engine and larger PowerUnits will use a 4-530 and a 4-1000 cc engines

(1) Taking orders now for 52 kW delivery starting in July 2003

Automotive Type Manufacturing

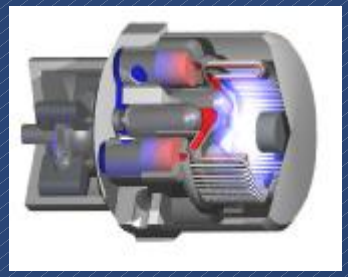


- Same suppliers
- Same materials
- Same processes
- 50% of the moving parts of IC engines

Common Engine for All Markets

Stationary Power

Waste Heat



Renewables and Resource Recovery

Combined Heat & Power

52 kW PowerUnit™

- **Electric output**
  - 480 VAC, 3-Phase, 60 Hz/50 Hz
- **Fuel requirements**
  - 2 psig inlet gas pressure (no compression)
  - 666 SCF/hr of natural gas per 52 kW output
  - 22.2 cfm of 50% methane per 52 kW output
- **Efficiency (cogen unit)**
  - 31.5% net electric, 80% CHP efficiency
  - Low maintenance (est. $0.008/kWh)
- **Noise level**
  - 65 dBA at 3 feet (in CHP mode)
- **Heat output**
  - 91 kWth, 312,000 BTU/hr at 52 kWe
  - 7 gal. per minute 125°F hot water at 52 kWe
- **CARB 2003 NOx compliant**

Distributed Generation PowerUnit

Cogen PowerUnit

PowerUnits Being Assembled

Assembled PowerUnits

Waste Heat PowerUnit

Landfill Gas PowerUnit

PowerUnits Being Shipped

25 Beta Locations by Year End

- Landfills
- Waste water plants
- Ag digesters
- Furnaces, Incinerators
- Dorm, Hotel

225 kW shipment to Michigan landfill operator

Installation at Landfills

A 50 kW installation at a landfill in Michigan

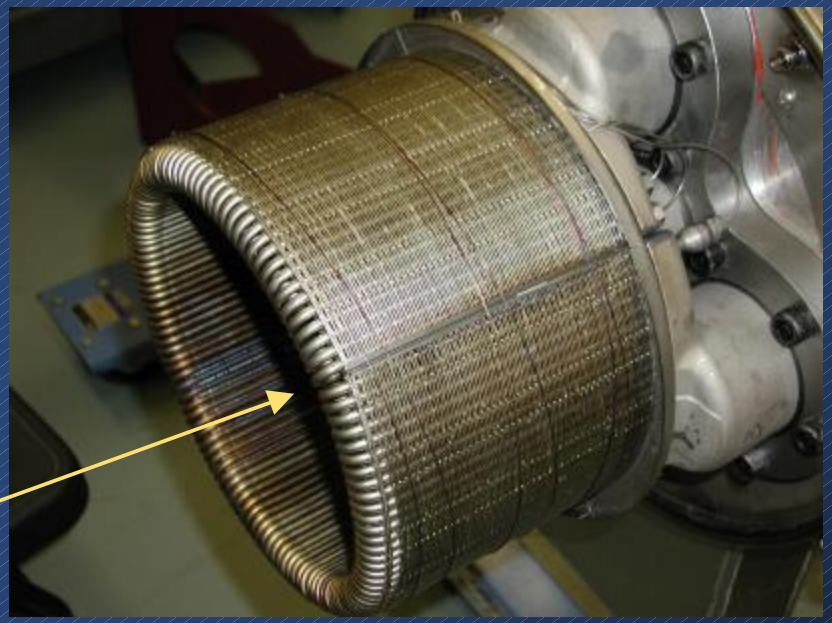
A 200 kW installation at a landfill in Michigan

Why STM

Low Grade Methane

- Current Products - 500 BTU
- 2003 Products - 300 BTU
- Higher levels siloxane, sulfur

This is where the combustion occurs



Heater tubes in external combustion heater head

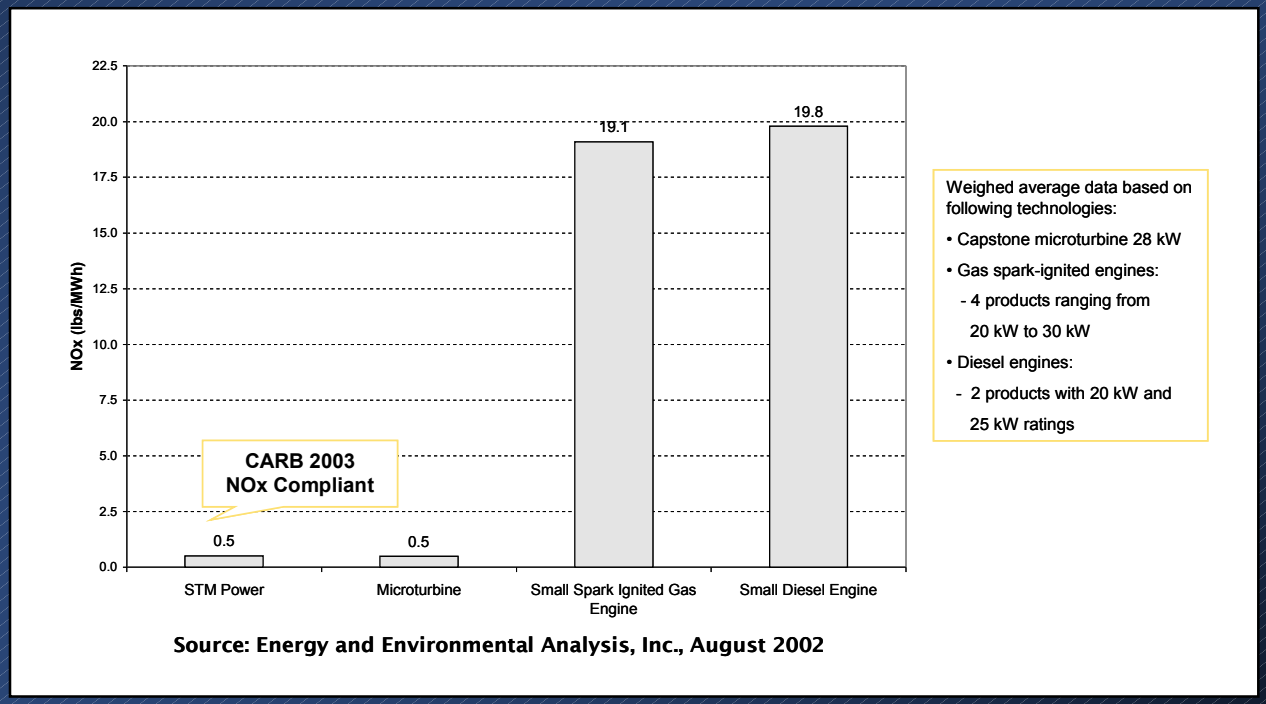
No Compression

- 2 psig inlet pressure
- No need for compressor

200 kW installation at a Michigan landfill

Ultra-Low NOx

- Able to meet California and Texas NOx standards
- No muffler or catalytic converter
- Unburned hydrocarbons too low to measure



Low Cost Cogen

- 31.5% electric efficiency
- 80% total system efficiency
- Onboard w/w heat exchanger
- Simple, all-in-one packaging

STM Cogen CHP unit

Low Cost Installation

- Based on induction generator
- No inverters in grid parallel
- No expensive compressor
- No expensive heat exchanger

50 kW installation at a Michigan landfill

STM versus IC Engines

IC Engine	STM PowerUnit
Cannot burn low BTU	Estimated down to 300 BTU
High maintenance cost (2.0 cents)	Low Maintenance cost (.8 cents)
Costly NOx compliance	NOx at 0.5 lbs/MWh. No muffler
Capacity factor challenged	Scalable from 52 kW
Difficult cogen option	On-board cogen capability

STM versus Microturbines

Microturbines	STM PowerUnit
25% LHV efficiency	31.5% LHV efficiency (cogen)
90,000 RPM	1,800 RPM
60 psig, expensive compressor	2 psig, no compressor
High cost CHP ($133 per kW)	Low cost CHP ($65 per kW)
Siloxane intolerant	Siloxane tolerant
Loud, high pitch noise	Quiet
Aerospace derived technology	Automotive derived technology

Game Changers

Vision – Easy Cogen

- 80% total system efficiency
- Cogen is all-in-one. No separate air-to-water heat exchanger
- 125°F water. One million tons in place supplies about 110 gallons per minute
- Perfect for space heating (garages, offices, greenhouses)
- Pre-heat for higher temperature processes
- Landfill revenues increased. At $5.00 per MCF of natural gas, value of heat is about $165,000 per year per 1 million tons in place at 50% methane

Greenhouse applications are one possible cogen application

Vision - Solar Hybrid on Landfill Gas

- Solar power during the day
- LFG power at night
- Higher solar electric rates
- Solar buy down
- Turn landfills into solar parks
- Landfill revenues increased.
  Assuming 1 million tons in place, premium of 4¢/kWh would generate about $150,000 additional annual revenue
- Super green credits

Alpha Unit installed in 2000 at Salt River Project.
Joint venture with SAIC. STM engine inside.

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Vision – Biogas for Transportation

- STM engine in series hybrid bus
- Compressed LFG for biogas fuel
- CARB 2003 NOx compliant
- Landfills as metro bus garages
- Sanitary vehicle refueling stations
- Landfill revenues increased.
  Assuming 1 million tons in place, 50% methane would have a comparable CNG price of about $3.00 per mcf based on today's $5.00 per mcf for natural gas.

STM alpha PowerUnit installed in Singapore Technologies bus at Solectria plant in Boston. STM engine inside.

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Game Changer – STM Stirling Engine

- Lower life cycle cost for LFG operator
- Low estimated cogen cost – 80% efficient
- CARB 2003 NOx compliant
- 300 BTU landfill gas in 2003 models
- Scalable from 52 kW
- Plug and play installation
- Vision to increase landfill revenues
  - Low Cost Cogen
  - Solar Hybrid
  - Biogas Transportation
- Commercial units available July 2003

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